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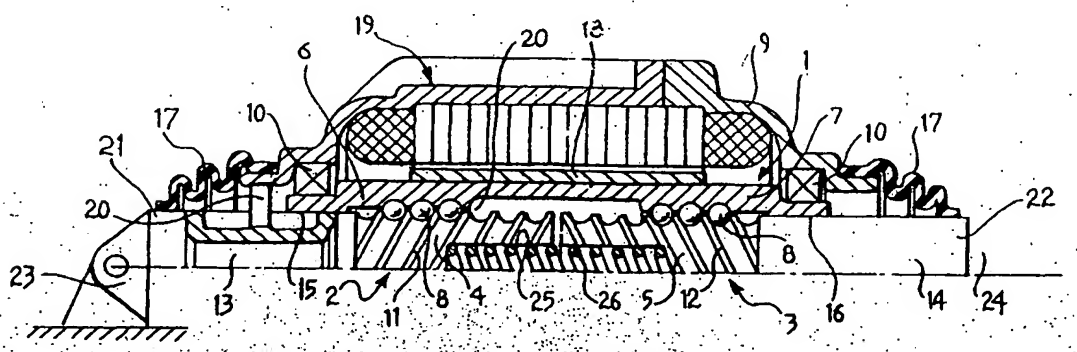
(54) Title: TWIN SCREW ACTUATOR



(57) Abstract: A screw actuator comprises a nut member (1) having two coaxial separate and different screw threads (6, 7) and two screws (2, 3) with different screw threads (4, 5) corresponding to the screw threads of the nut member (1). At least one of the screws (2, 3), at its end facing away from the other screw, has an actuating head (21, 22). The actuator further comprises a housing (9) and a drive (19, 41) for rotating the nut member (1) and the screws (2, 3) with respect to each other.

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Twin screw actuator

The invention is related to the field of screw actuators. Such actuators are applied in various fields, for instance in the automotive field for actuating brakes, clutches, gearboxes etc.

The object of the invention is to provide a versatile screw actuator which fits a wide range of applications.

This object is achieved by means of a screw actuator comprising a nut member having two coaxial, separate and different screw threads, and two screws which each have a different screw thread corresponding to screw threads of the nut member, at least one of said screws at its end facing away from the other screw having an actuating head, a housing and drive means for rotating the nut member and the screws with respect to each other.

The actuator according to the invention comprises a single nut and two screws. This layout has a compactness which is required for applications such as in brake discs, and also offers further desired possibilities which are addressed below.

The drive motor has a stator which is connected to the housing, and the rotor which engages the nut member, e.g. through a gear reduction means. Preferably, the screws are coupled in rotational direction, so as to obtain a uniform control thereof through the nut. For instance, the screws at there facing ends are coupled through a spline connection. For preventing undesirably play movements, the screws at their facing ends are preloaded by a compression spring.

The screws are each supported with respect to the nut member by means of a bearing, e.g. a plain bearing, a needle bearing. The nut is supported with respect to the housing by means of at least one rolling element bearing, or supported on the screws by means of a plain bearing or a needle bearing. The rotor is supported with respect to the nut by means of a bearing, e.g. a plain bearing or a needle bearing.

According to a first embodiment, both screws extend from the housing, and both have an actuating head at their ends facing away from each other. This embodiment can e.g. be applied in a clutch or a brake.

According to a second embodiment, one of the screws is axially fixedly supported with respect to the housing, the nut member being translatably but non-rotably guided with respect to the housing. In this case, the motor and the nut member are accommodated in a sub-housing, said sub-housing being slideable in axial direction with respect to the housing.

This embodiment is particularly suitable for actuating a gearbox. In this case, the actuating end should carry out both a translating as well as a rotating movement. To that end, the axially fixed screws is driveable in rotational direction by a further motor.

The invention will now be described in further detail with reference to several embodiments shown in the figures.

Fig. 1 shows a first embodiment of the screw actuator according to the invention, in particular for a clutch;
Fig. 2 shows a second embodiment, in particular for a

gearbox;
Figs. 3 and 4 show a third and a fourth embodiment respectively of the invention.

The screw actuator shown in fig. 1 comprises a single nut 1 as well as two screws 2, 3 which have respective left hand and a right hand screw threads 4, 5. The nut member 1 has corresponding nut sections 6, 7; the screws 2, 3 and the nut sections 6, 7 engage each other through balls 8 (ball screw). The nut member 1 is supported within a housing 9 by means of two rolling element bearings 10.

The screws 2, 3 have, beside the screw sections 11, 12, cylindrical sections 13, 14. These cylindrical sections 13, 14 are supported by the cylindrical parts 15, 16 of the nut member 1. These cylindrical parts 15, 16 together with the cylindrical sections 13, 14, each form a plain bearing for the respective screws 2, 3. The screws 2, 3 are sealed with respect to the housing 9 by means of bellows 17. The nut member 1 furthermore carries the rotor 18 of the motor 19, the stator 20 of which is connected to the housing 9.

The screw 2 is fixed in rotational direction with respect to the housing 9 by means of the splined/grooved connection 20. Furthermore, the screws 2, 3 have protruding ends or actuating heads 21, 22, which each have a mounting flange 23, 24 for connecting the screw actuator to the surrounding structure. By means of these mounting flanges 23, 24, the screw actuator is non-rotably held. Furthermore the screws 2, 3 at their facing ends each have a bore 25, within which a compression spring 26 is held. This compression spring ensures that any play will be minimised.

In service, the motor 19 is energised, which makes the nut member 1 rotate with respect to the housing 9. Depending on the rotational sense of the nut member 1, the screw members 2, 3 are displaced from or towards each other, whereby an actuating movement is exerted through the flanges 23, 24.

In the embodiment of fig. 2, one of the screws 2 is rotatably, but not axially moveable, being supported by means of bearings 27, 28. The nut member 1 and the motor 19 are accommodated within a sub-housing 29, which is axially slidable within the housing 9. This housing 9 is closed at the end 30, and has a fixing flange 31 at the opposite end, for fixing the screw actuator in question to a gearbox.

At their facing ends, the screws 2, 3 have bores 25 in which a key 32 is accommodated. The key and the bores 25 are not round, which makes that the screws 2, 3 are axially moveable with respect to each other, but not rotatable. The screws 2, 3 are preloaded by means of a spring 44.

By energising the motor 19, the screws can be moved away from each other, whereby the nut 1 moves as well. This is made possible by the fact that the nut 1 and the motor 19 are accommodated in the sub-housing 29. This sub-housing 29 is non-rotatable due to splined/grooved connection 33.

The screw 3 has an actuating head 22, which carries a fork 34 which is connectable to a gear lever in the gearbox (not shown). By moving the screw 3 back and forth, the switching translation for a gearbox can be obtained.

Also, the fork 34 should carry out a rotating movement in order to shift gear. This is made possible by a further motor

35, the stator 36 of which is connected to the housing 9, and a rotor 37 of which is connected to the screw 2.

By energising the motor, the screw 2, and thus the screw 3 through spline connection 25, 32 as well as the sub-housing 29 are rotated in the desirable sense, thus rotating the fork 34 of the screw 3, whereby the desired gear shifting rotation is obtained.

In the embodiment of fig. 3, which to a large extent resembles the embodiment of fig. 1, the rotor 18 of the motor is connected to a separate sleeve 39, which by means of a bearing 38, e.g. a plain bearing, is rotatably supported with respect to the nut member 1. This nut member 1 carries an outwardly protruding flange 40 with an inwardly pointing gear wheel forming part of the reduction satellite of a gear wheel mechanism 41. This gear wheel mechanism 41 also engages the separate sleeve 39; thus, the rotations imparted the rotor 18 are decelerated through the gear wheel mechanism 41, so as to obtain the desired number of rotations of the nut member 1.

As in the embodiment of fig. 1, the screws 2, 3 are supported with respect to the housing 9 by means of a plain bearing which is constituted by the cylindrical parts 13, 14 of the screws 2, 3, and the cylindrical parts 15, 16 of the housing 9. In alternative, also a needle bearing may be applied here.

In the embodiment of fig. 4, no such bearings are provided between the screws 2, 3 and housing 9; instead, seals 42 have been provided to ensure the desired sealing function. The mechanism is now supported by means of deep groove ball bearings 43, which are positioned between the housing 9 and the separated sleeve 39 which carries the rotor 18 of the

motor. In turn, the separate sleeve 39, through the plain bearing or needle bearing 38, supports the nut member 1, which in turn supports the screws 2, 3 through the cylindrical parts 15, 16.

Again, a gear wheel reduction mechanism 41 is provided between the separate sleeve 39 and the nut member 1.

CLAIMS

1. A screw actuator comprising a nut member (1) having two coaxial separate and different screw threads (6, 7), and two screws (2, 3) which each have a different screw thread (4, 5) corresponding to the screw threads of the nut member, at least one of said screws (2, 3) at its end facing away from the other screw having an actuating head (21, 22), a housing (9) and drive means (19, 41) for rotating the nut member (1) and the screws (2, 3) with respect to each other.

2. A screw actuator according to claim 1, wherein the drive means comprise a motor (19), the stator (20) of which is connected to the housing (9), and the rotor (18) of which engages the nut member (1).

3. A screw actuator according to claim 2, wherein the rotor (18) engages the nut member (1) through a gear reduction means (41).

4. A screw actuator according to one of the preceding claims, wherein the screws (2, 3) are coupled in rotational direction.

5. A screw actuator according to claim 4, wherein the screws (2, 3) at their facing ends are coupled through a spline connection (25, 32).

6. A screw actuator according to any of the preceding claims, wherein the screws (2, 3) at their facing ends are preloaded by a compression spring (26).

7. A screw actuator according to any of the preceding

claims, wherein at least one of the screws (2, 3) is a ball screw.

8. A screw actuator according to any of the preceding claims, wherein the screws (2, 3) are supported with respect to the nut member (1) by means of a bearing (13, 15; 14, 16), e.g. a plain bearing, or a needle bearing.

9. A screw actuator according to any of the preceding claims, wherein the nut (1) is supported with respect to the housing (9) by means of at least one rolling element bearing (10).

10. A screw actuator according to any of the preceding claims, wherein the rotor (18) is supported with respect to the nut (1) by means of a bearing (38), e.g. a plain bearing or a needle bearing.

11. A screw actuator according to any of claims 1 to 9, wherein the rotor (18) is carried by a separate sleeve (38) which is supported with respect to the housing (9) by means of rolling element bearings (43).

12. A screw actuator according to any of the preceding claims, wherein both screws (2, 3) extend from the housing, and both have an actuating head (21, 22) at their ends facing away from each other.

13. A screw actuator according to any of the preceding claims, wherein the screws (2, 3) are supported with respect to the housing (9) by means of bearings (44, 45), e.g. plain bearings or needle bearings.

14. A screw actuator according to claim 1 to 10, wherein one of the screws (2) is axially fixedly supported with respect to the housing (9), the nut member (1) being translatably but non-rotatably guided with respect to the housing (9).

15. A screw actuator according to claim 14, wherein the motor (19) and the nut member (1) are accommodated in a sub-housing (29), said sub-housing (29) being slidable in axial direction with respect to the housing (9).

16. A screw actuator according to claim 14 or 15, wherein the axially fixed screw (2) is driveable in rotational direction by a further motor (35).

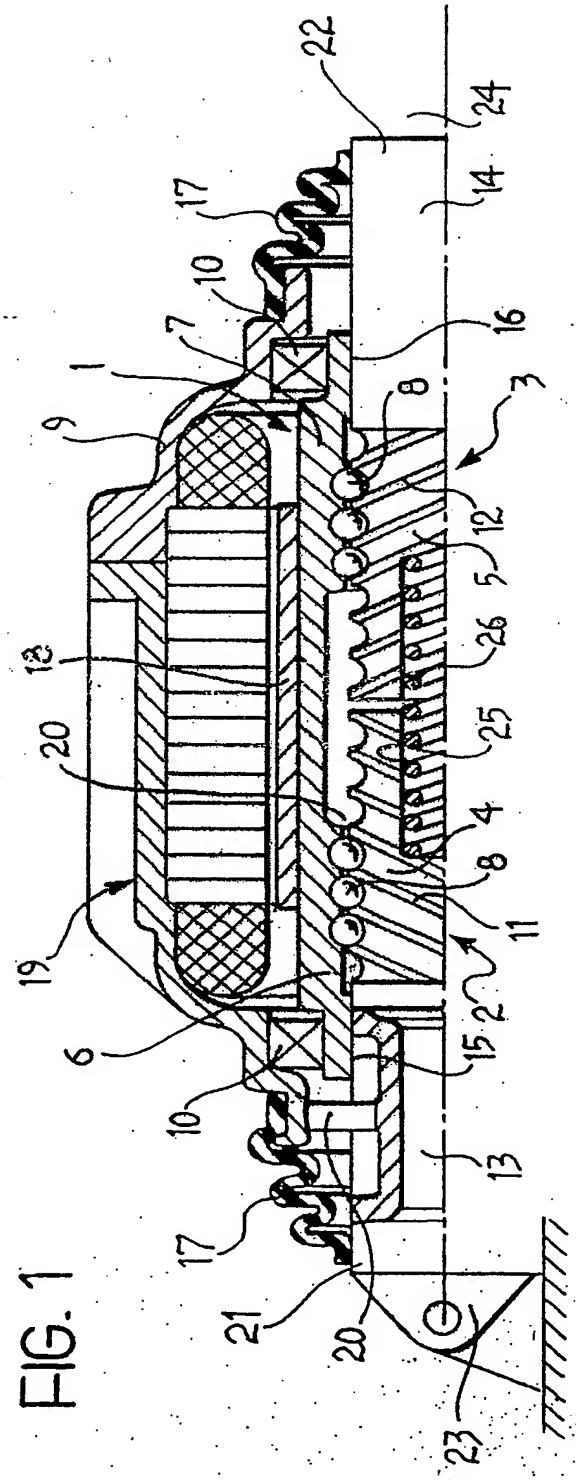
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FIG. 1

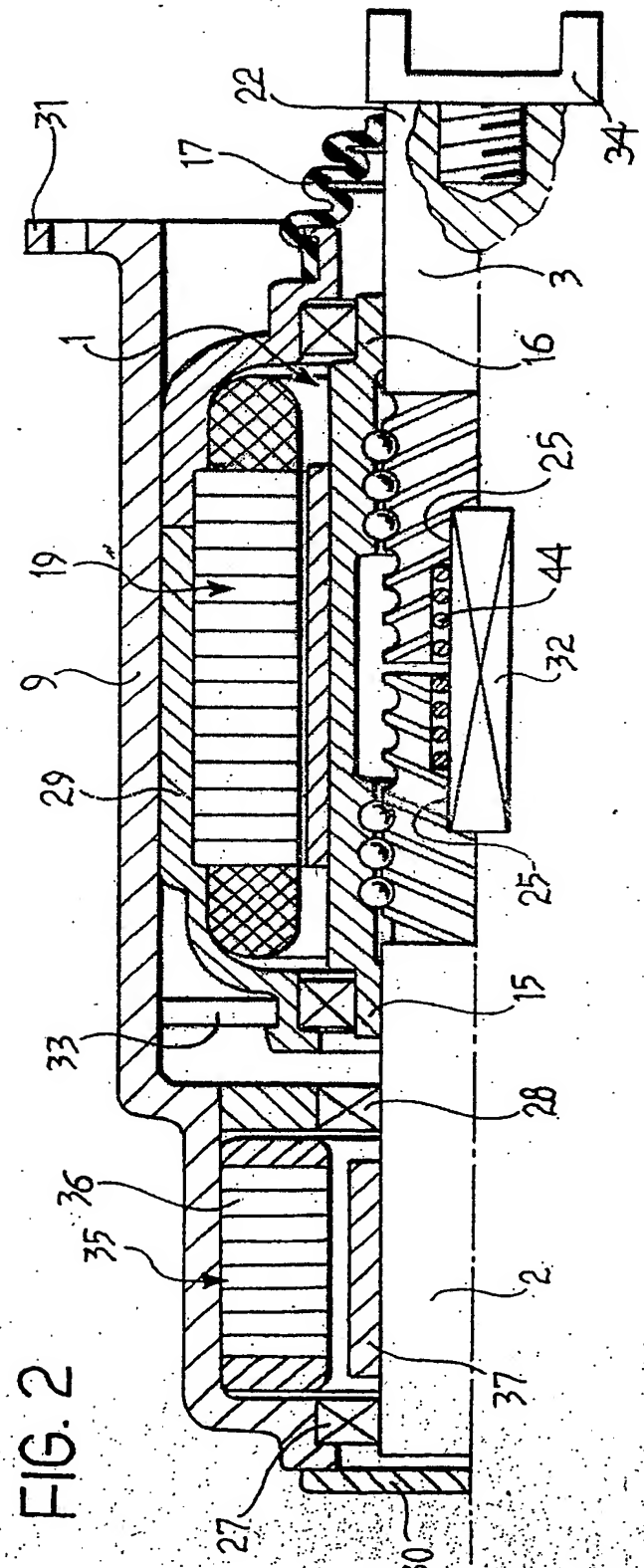
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FIG. 2

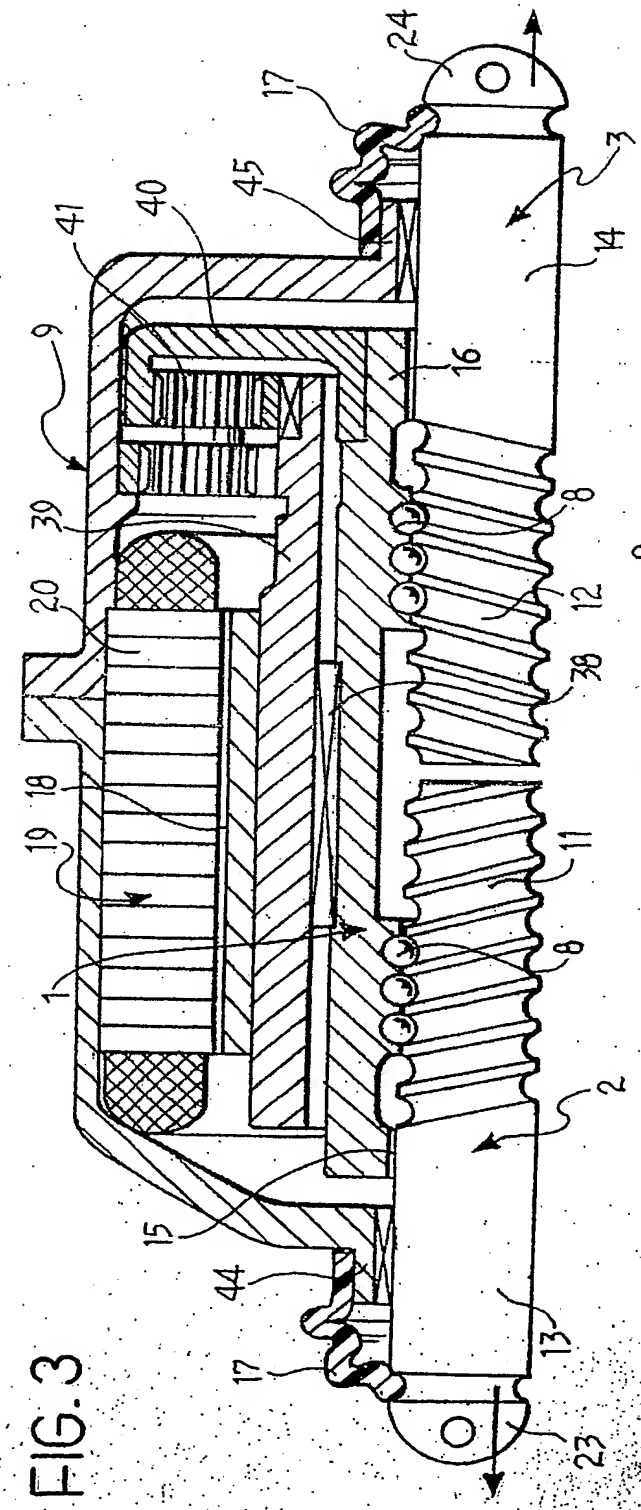
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FIG. 3

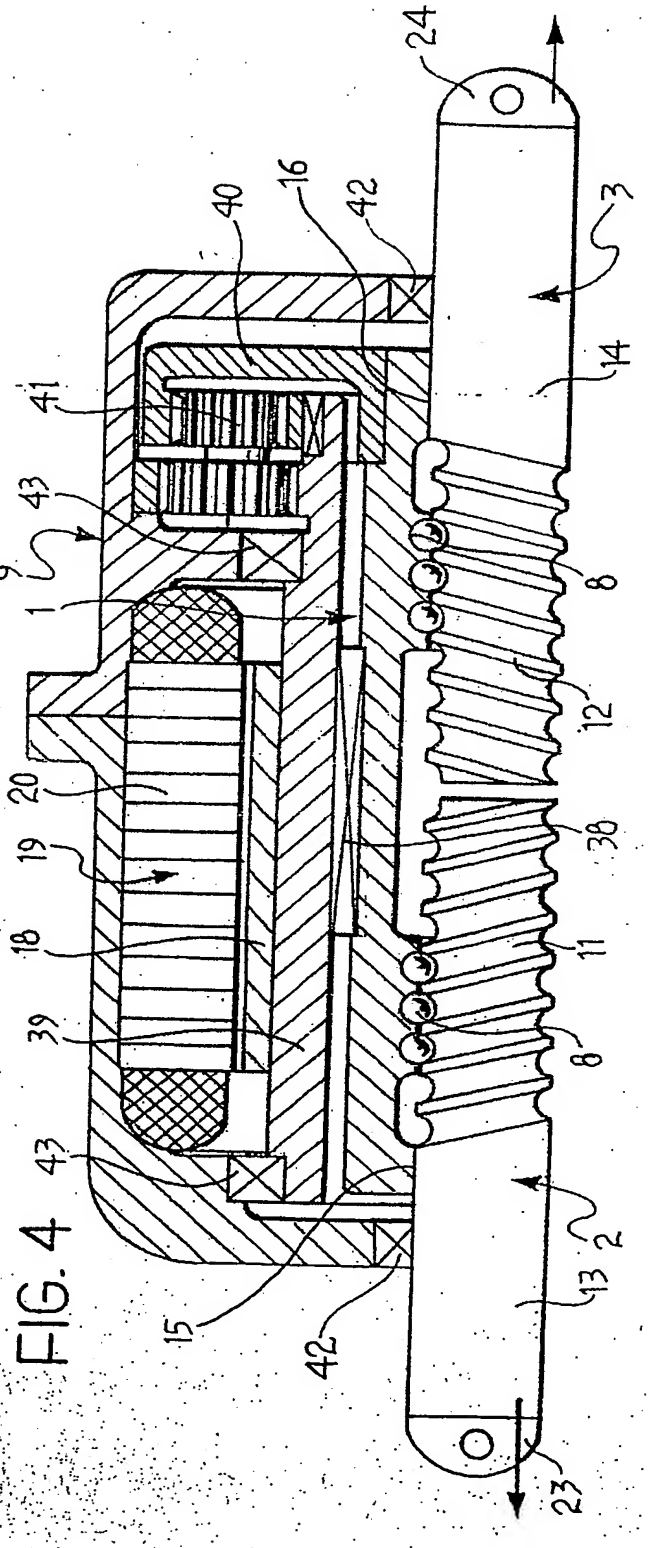
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FIG. 4

INTERNATIONAL SEARCH REPORT

PCT/IB02/05175

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16D65/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 148 523 A (GIRLING LTD) 16 April 1969 (1969-04-16) page 1, line 41 -page 1, line 45 figure 2	1,4,7,8
A	WO 01 42677 A (ZWARTS JACOBUS ;KAPAAN HENDRIKUS JAN (NL); SKF ENGINEERING & RES C) 14 June 2001 (2001-06-14) abstract; figures 3-6	1-16
A	WO 01 51825 A (KAPAAN HENDRIKUS JAN ;SKF ENGINEERING AND RES CT B V (NL)) 19 July 2001 (2001-07-19) abstract; figure 1	1-16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kyriakides, L.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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